[Second Edition.]

# PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION.

## Improvements in Dynamo Electric Machines.

We, GEORGE HERBERT FLETCHER, of 22, Glentilt Road, Ecclesall, Sheffield, in the County of York, a subject of the King of Great Britain, and METROPOLITAN-VICKERS ELECTRICAL COMPANY LIMITED, of 4, Central Buildings, in the City of Westminster, a British company, do hereby declare the nature of this invention to be as follows:—

This invention relates to dynamo electric machines of the totally enclosed type, that is to say, machines wherein the working parts such as the field magnet and armature windings, the brush gear and co-operating rotating parts and the rotor bearings are completely enclosed by means of end bells or other encasing members. The object of the invention is to provide an improved air cooling system for such machines whereby efficient cooling may be obtained without the admission of air from the exterior to the enclosed working parts.

According to the invention the cooling air is passed through passages in the rotor which communicate with inlet and outlet openings located within the bearings, that is to say, openings formed in the shaft or end portions of the rotor which project beyond the bearings and the air passing through the passages in the rotor is prevented from entering the enclosed space containing the working parts of the machine. In addition the yoke or frame of the machine may be cooled by the provision of one or more passages through which cooling air is passed. Preferably the yoke or frame is jacketed and is provided with projecting ridges which divide the jacket into a plurality of channels and increase the cooling surfaces, and according to a further feature of the invention the yoke or frame of the machine is cast with relatively thick single or multiple helical ridges which provide ducts or channels offering long and restricted paths and a consequent high velocity for the cooling air. At the same time said helical ridges increase the strength of the yoke or frame and add to the volume of magnetisable material therein. The cooling air may be passed through the rotor and through the jacket on the yoke or frame either in series or in parallel and for this purpose a fan may be employed which is advantageously mounted upon the rotor and enclosed within a protecting frame or casing.

According to one arrangement the fan may be located at one end of the machine so that it draws air first through the air jacket and then through the rotor in series. According to another arrangement the air may enter both the rotor and the yoke jacket at either end of the machine and be drawn therethrough in parallel by means of a fan located at the other end of the machine.

As previously set forth the cooling air may be passed through passages formed in the rotor or through the commutator spider and the rotor spider and in both cases the rotor is so constructed that the air passing through it cannot enter the enclosed space containing the working parts of the machine.

Dated the 6th day of November, 1923.

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2, Norfolk Street, Strand, London, W.C.,
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[Price 1/-]

COMPLETE SPECIFICATION.

## Improvments in Dynamo Electric Machines.

We, GEORGE HERBERT FLETCHER, of 22, Glentilt Road, Ecclesall, Sheffield, in the County of York, a subject of the King of Great Britain, and METROPOLITAN-VICKERS ELECTRICAL COMPANY LIMITED, of 4, Central Buildings, in the City of Westminster, a British company, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to dynamo electric machines of the totally enclosed type, that is to say, machines wherein the working parts such as the field magnets and armature windings, the brush gear and co-operating rotating parts and the rotor bearings are completely enclosed by means of end bells or other encasing members. The object of the invention is to provide an improved air cooling system for such machines wherein efficient cooling may be obtained without the admission of air from the exterior to the enclosed working parts.

It has been proposed for the purpose of cooling dynamo electric machines to pass air through the armature body and discharge it outside the casing in such manner that it does not come in contact with the working parts such as the windings, commutator and brushes, this being obtained by enclosing such working parts at a commutator end by means of a fixed end bell and passing the cooling air through an inlet opening in the shaft within the bearing thereof and thence through substantially radial passages into longitudinal passages in the armature core and thence through a centrifugal fan at the other end of the machine to the exterior thereof, the casing of the centrifugal fan being provided with annular ribs or rings cooperating with other ribs or rings provided both on the outer end face of an annular portion of the machine casing and on an end disc. With such arrangement however the enclosure of the aforesaid working parts is not complete since it is effected by means of surfaces rotating at a high speed relative to one another, namely the casing of the centrifugal fan on the one hand and the aforesaid fixed casing members on the other hand.

According to the present invention the working parts such as the field magnets, armature windings commutator and brush gear are completely enclosed by means of an end bell at each end of the machine, that is to say, by means of casing members which do not have relative rotation, and the cooling air is passed through longitudinal passages in the rotor which communicate with inlet and outlet openings located within both of the bearings or in those parts of the shaft or sleeves upon which the two bearing races are mounted, namely openings formed in portions of the rotor which project through and beyond the bearings, the air passing through the passages in the rotor being prevented from entering the enclosed space containing the working parts of the machine. In addition the yoke or frame of the machine or the exterior portion of the punchings in the case of a machine with a skeleton-type frame, may be cooled by the provision of one or more passages through which cooling air is passed. Preferably the yoke or frame is jacketed and is provided with projecting ridges which divide the jacket into a plurality of channels and increase the cooling surfaces, and according to a further feature of the invention the yoke or frame of the machine is cast with relatively thick single or multiple helical ridges which provide ducts or channels offering long and restricted paths and a consequent high velocity for the cooling air. At the same time said helical ridges increase the strength of the yoke or frame and add to the volume of magnetisable material therein. The cooling air may be passed through the rotor and through the jacket on the yoke or frame either in series or in parallel and for this purpose a fan may be employed which is advantageously mounted upon the rotor and enclosed within a protecting frame or casing.

According to one arrangement the fan may be located at one end of the machine so that it either draws or forces air first through the air jacket and then through the rotor in series. According to another arrangement the air may enter both the rotor and the yoke jacket at either end of the machine and be drawn therethrough in parallel by means of a fan located at the other end of the machine. According to a further arrangement the air may be drawn through the rotor and then forced through the yoke jacket after passing through the fan.

To enable the invention to be clearly understood it will now be described by way of example with reference to the accompanying drawings in which Fig. 1 is an elevation partly in section of a direct current machine having an air cooling arrangement in accordance with the invention, Fig. 2 is a sectional elevation of part of the yoke showing a modification, and Fig. 3 is a section on the line III—III of Fig. 2. Fig. 4 is a view similar to Fig. 1 of another modification.

Referring to Fig. 1 of the drawings, the machine therein illustrated comprises a field magnet system, one pole 1 of which is shown connected to a substantially cylindrical yoke 2, an armature 3 having a plurality of slot conductors 4 and a commutator 5 which co-operates with collector brushes 6. The armature 3 rotates in bearings which are enclosed as shown, and comprises the usual slotted core which may be mounted directly on the shaft or as shown upon a spider 8 which in turn is mounted on a shaft 9. Upon the ends of the shaft 9 are mounted cylinders 10 and 11, a spacing cylinder 12 being interposed as shown between the cylinder 10 and the spider 3. The cylinder 10 may be the usual commutator spider. The cylindrical yoke 2 is closed at the commutator end of the machine by means of a bell 13, whilst at the other end it is closed by means of a bell $13^a$. A layer of insulating material 14 is provided between the windings 4 and the cylinders 10, 11 and 12, the arrangement being such that the field magnets, the armature windings and the commutator and brushes are totally enclosed, namely by the yoke 2 and the end bells 13 and $13^a$, the bearing covers, the outer surface of the cylinders 10, 11 and 12 and also the axial vent ducts in the armature core or spider.

The cylinders 10 and 11 project beyond the ring bearings and are provided with longitudinal passages 15 and 16 respectively, the cylinder 12 being similarly provided with longitudinal passages 17. and the arrangement is such that passages are formed through the length of the rotor through which cooling air can pass without being admitted to the above-mentioned space containing the poles 1, armature windings 4, commutator 5 and brushes 6.

A fan 18 of any convenient type is mounted upon the commutator end of the shaft 9, being preferably protected by means of a casing 19. The said fan is arranged to draw air longitudinally through the passages 16, the rotor spider 8 or armature core vent ducts and the passages 17 and 15.

In the arrangement shown in Fig. 1 the yoke 2 is provided with a helical ridge or thread 20 and is enclosed in an external casing 21 so that a helical jacket space or channel 22 is provided. The jacket space 22 is furnished with an air inlet 23 and an outlet 24. An air-tight cover 25 is provided at the right hand end of the machine so as to place the outlet opening 24 of the jacket 22 in communication with the rotor passage 16. The fan 18 thus draws air through the yoke jacket and through the rotor in series.

With the arrangement above described it will be appreciated that by reason of the helical ridge or thread 20 which is relatively thick and may be single or multiple, the channel 22 is long and offers an extended cooling surface and a restricted path for the air, resulting in a consequently high air velocity. At the same time the threads 20 increase the mechanical strength of the yoke 2 and add to the volume of magnetic material therein. As previously set forth, the air passing through the rotor and the jacket efficiently cools the enclosed working parts of the machine without coming into contact with the latter.

Instead of the helical ridges 20 illustrated in Fig. 1, longitudinal ridges 26 may be employed as illustrated in Figs. 2 and 3, providing a plurality of longitudinal air passages 27, a plurality of openings 23 and 24 and the jacket cover 21 being provided similar to those previously described.

Whilst in the arrangement shown in Fig. 1 the air is drawn through the rotor and jacket in series, according to the modified arrangement illustrated in Fig. 4 the cooling air is drawn through the rotor and the jacket in parallel. The fan 18 is arranged at the opposite end of the shaft so that during its rotation it draws air simultaneously through the openings 24 in the jacket and from the passages 16 in the rotor. In this modification the air passes in the same direction through the jacket as that described in Fig. 1 but in the reverse direction through the rotor, as clearly shown by the full line arrows.

In some cases means may be provided for circulating the air about the totally enclosed working parts. Thus an auxiliary fan 28 may be provided upon the rotor at the right hand end thereof within the end bell $13^a$ as clearly shown in Fig. 4, a cylindrical liner 29 being provided within the yoke 2 and spaced therefrom so as to provide a substantially

cylindrical passage or jacket space 30. With this arrangement the fan draws air through the air gap between the magnet poles from left to right and returns it from right to left through the passage or the jacket space 30 as shown by the dotted arrows. Thus the air circulated by the fan 28 extracts heat from the hot surfaces of the enclosed working parts and is then cooled by being brought into contact with the surfaces which are cooled by the external air circulated by means of the fan 18.

It will be understood that various modifications may be made without departing from the scope of the invention. For example, the cooling air may be passed through passages formed in the rotor, or through the commutator spider and the rotor spider, the rotor being so constructed in both cases that the air passing through it cannot enter the enclosed space containing the working parts of the machine.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A dynamo electric machine in which such working parts as the windings, commutator and brushes are completely enclosed against the admission of external air by means of fixed end bells and wherein cooling air is passed from the exterior of the machine through the rotor *via* longitudinal passages within both of the journals, or in those parts of the shaft or sleeves upon which the two bearing races are mounted, substantially as set forth.

2. A dynamo electric machine in which such working parts as the windings, commutator and brushes are completely enclosed against the admission of external air and wherein cooling is provided by the passage of external air flowing in contact with surfaces which are external to the space containing the enclosed working parts and are in part formed by spirally arranged ribs on the exterior surface of the yoke, substantially as described.

3. A dynamo electric machine as claimed in Claim 1, the yoke of which is provided with a cooling jacket through which the external cooling air is drawn or forced, substantially as described.

4. A dynamo electric machine as claimed in Claim 3, in which the yoke is formed with external longitudinal ridges within the cooling jacket so as to provide restricted paths and additional cooling surfaces for the cooling air, substantially as described.

5. A dynamo electric machine as claimed in any one of the preceding claims, in which a fan mounted upon the rotor externally to the bearings draws or forces the external cooling air through the yoke jacket and the rotor passages in series or in parallel.

6. A dynamo electric machine as claimed in any one of the preceding claims, in which the enclosed air is circulated about the enclosed working parts, substantially as described.

7. Totally enlosed dynamo electric machines provided with the cooling arrangements, substantially as herein described with reference to the accompanying drawings.

Dated the 5th day of August, 1924.

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2nd Edition



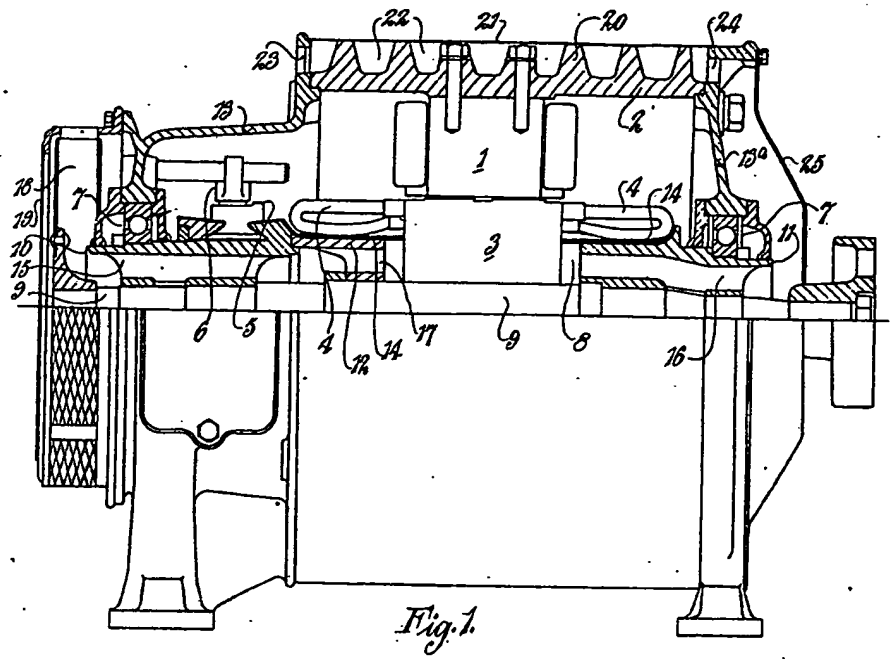

Fig. 1.

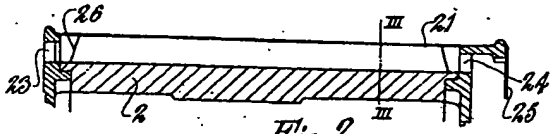

Fig. 2.

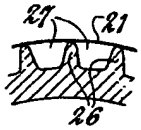

Fig. 3.

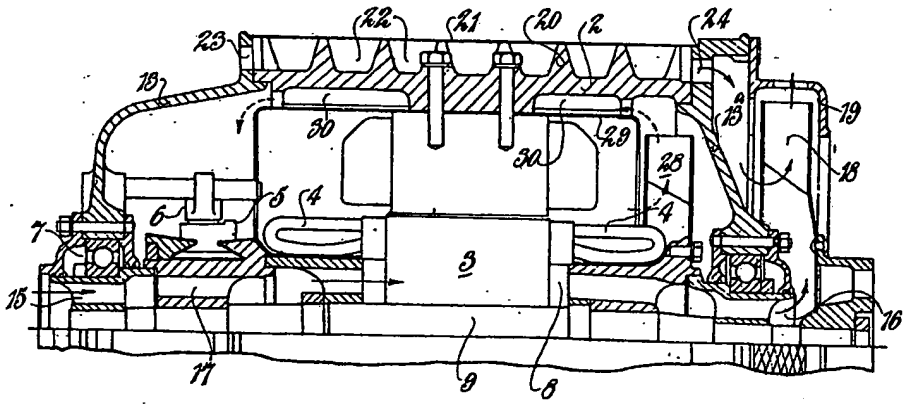

Fig. 4.

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